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Docket No.: I0168-707719

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants:	Gary Ganzi et al.
Serial No:	10/712,250
Confirmation No:	8579
Filed:	November 13, 2003
For:	WATER TREATMENT SYSTEM AND METHOD
Examiner:	Phasge, Arun S.
Art Unit:	1795

CERTIFICATE OF TRANSMISSION UNDER 37 C.F.R. § 1.8(a)

The undersigned hereby certifies that this document is being electronically filed in accordance with 37 C.F.R. § 1.6(a)(4), on the 26th day of August 2008.

/elias domingo/
Elias Domingo

Commissioner for Patents

DECLARATION OF GARY C. GANZI UNDER 37 C.F.R. § 1.132

Sir:

I, the undersigned, Gary C. Ganzi, declare that:

1. I am a co-inventor, together with Anil D. Jha, Frederick Wilkins, Evgeniya Freydina, Aytac Sezgi, and Reshma Madhusudan, of the claimed subject matter of the above-identified patent application. I make this declaration in support of that application and in response to the Office Action mailed April 21, 2008.

2. I have a Bachelor of Science in Chemical Engineering from the Massachusetts Institute of Technology and a Master of Science, also in Chemical Engineering, from the University of Delaware. I received a *Juris Doctor*, *magna cum laude*, from Suffolk University Law School.

I am Chairman of the American Society for Testing Materials Committee on Electrodeionization (D19.08.06). I also am a Registered Professional Engineer (Chemical) in Massachusetts.

As a Technical Group Leader at Ionics, Inc., for about seven years, I was involved in developing electrically-driven separation devices and components thereof such as ion exchange membranes and resins. I also designed and developed various aspects of electrolytic apparatus, including electrodialysis and electrodeionization devices, as well as systems thereof, as Development Manager at Millipore Corporation, and as Director of Research and Development at Ionpure Technologies Corp. Further, as Vice President of Research and Development at United States Filter Corporation, I was involved in designing, optimizing and implementing electrodialysis and electrodeionization devices, components thereof, and systems that utilize such devices. I have more than 30 years of experience in the fields of membrane and ion exchange separation.

Further, I have several inventions directed to water treatment or purification as well as to electrodeionization apparatus and their design, assembly, and operation. For example, I am an inventor or co-inventor on several patents including, but not limited to, U.S. Patent Nos. 4,430,226; 4,632,745; 4,474,929; 4,925,541; 4,956,071; 5,211,823; 5,259,936; 5,306,466; 5,558753; and 5,858,191. I have also presented and published over 20 articles directed to electrodeionization, water purification, and ion-exchange membrane properties. Thus, I am familiar with the art of water treatment and electrodeionization as well as membrane and ion-exchange separation and the characteristics of such components.

3. I have reviewed the Office Action dated April 21, 2008 as well as the references cited therein. I understand the rejection in the Office Action relies on the disclosure of Mir in U.S. Patent No. 6,296,751 (hereinafter "Mir"). I understand that because Mir discloses that water splitting occurs at the interface of an anion material or membrane with a cation material or membrane, the rejection relies on the suggestion that the cation membrane 142 in Mir's FIG. 8

(reproduced below) can be replaced with a cation resin, thereby resulting in a compartment that has anion membrane 152 and cationic spacer 134 disposed adjacent thereto (illustrated below in the drawing labeled "Modified").

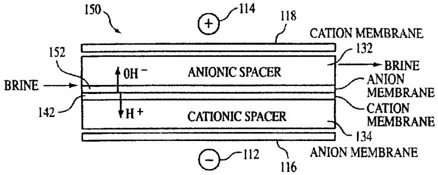
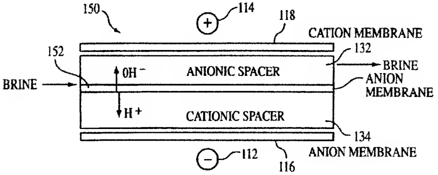


FIG. 8



Modified

4. Mir discloses, at column 8, lines 39 *et seq.* and with reference to FIG. 8, a unitary, subdivided concentrating channel 150 between a cation membrane 118 and an anion membrane 116. The unitary concentration channel 150 is subdivided by juxtaposed anion membrane 152 and cation membrane 142. Anion membrane 152 is arranged to face cation membrane 118, and cation membrane 142 is arranged to face anion membrane 116. Anion

membrane 152 is separated from cation membrane 118 by an anionic spacer 132. Cation membrane 142 is separated from anion membrane 116 by cationic spacer 134. I read Mir's "spacer 134" to be a layer of cation exchanging material, as noted on column 8, lines 14-16. Upon imposition of an electric field, cations enter channel 150 from an adjacent ion depleting channel through cation membrane 118, and anions, such as bicarbonate and chloride ions, enter channel 150 from an adjacent ion depleting channel through anion membrane 116. Mir also notes that water splitting takes place between membrane 152 and 142 under the influence of an electric field. The water necessary for the hydrogen ion and hydroxide ion production at the interface between juxtaposed cation and anion membranes 142 and 152 is apparently supplied by diffusion through the membranes. As a result of the hydrogen ion formation via water splitting, cation spacer 134 (and the liquid within and surrounding it) is rendered acidic. Mir claims that this acidification prevents scale formation as hydrogen ions travel under the influence of an electric field into the subdivided concentration channel 150 through the sub-channel containing cation spacer 134 to meet newly arriving anions, such as bicarbonates and chlorides, as they enter channel 150 via either the liquid flow or anion membrane 116. Significantly, these anions (such as bicarbonates and chlorides) are trapped in the subdivided channel containing cation spacer 134 because they are inhibited or blocked from further transport toward anode 114 by cation membrane 142. Thus as ion transport proceeds under the influence of an electric field, the stream in subdivided channel containing cation spacer 134 becomes a concentrated strongly acidic waste stream. Analogously, in the opposing subdivided channel containing anionic spacer 132, cations (such as sodium or calcium ions) are concentrated and become associated with hydroxide ions being generated at the juxtaposed anion/cation interface. Thus in Mir, channel 150 forms subdivided streams containing concentrated acidic waste due to entering anions and concentrated basic waste due to entering cations.

5. Mir also explains, at column 8, lines 4-7, that the arrangement of FIG. 8 serves the same purpose as the arrangement of FIG. 9 of providing "a reduced pH at the surface of the anion membrane so as to avoid CaCO3 [sic] precipitation." I particularly note that Mir explains at column 8, lines 49-52, that concentration channel 160 illustrated in FIG. 9 is structurally similar to channel 150 except that anion permeable membrane 152 and cation permeable membrane 142 is replaced by a bipolar membrane 162, and water splitting occurs at the interface of the cation and anion parts of bipolar membrane 162. I therefore conclude, as a person skilled in the art, that the anion membrane 152/cation membrane 142 configuration in FIG. 8 serves as a bipolar membrane.

6. I note that bipolar membranes can be characterized as a laminate of a cation and an anion exchange layer and are commonly used to facilitate dissociation or disproportionation of compounds. For example, bipolar membranes accelerate water disproportionation phenomena into hydronium ions (H_3O^+) and hydroxyl ions (OH^-) in an electric field applied with sufficient strength. Water splits into hydronium and hydroxyl species at the interface between the cationic layer and the anionic layer. Bipolar membranes also advantageously facilitate the transport or migration of charged species therethrough, and inhibition of counter species. In doing so, bipolar membranes also serve to prevent the reverse reaction by facilitating separation, i.e., transport, of the hydronium ions from the hydroxyl ions, and by inhibiting migration of the hydroxyl ions.

7. I then note that Mir emphasizes at column 8, lines 56 *et seq.* that "[b]ipolar membrane 162 furthermore prevents the transfer of cations to the acidic brine component in spacer 134 and of anions to the basic brine compartment in spacer 132." This is consistent with the explanation at paragraph 6 above. A person skilled in the art would thus understand that a bipolar membrane provides at least two essential features when utilized in water splitting operations: catalyzing the disproportionation phenomenon, and separating by oppositely

transporting the hydronium ion and hydroxyl ion products to prevent the reverse reaction. I thus conclude that cation membrane 142 in FIG. 8 of Mir must also serve to prevent or inhibit transport of hydroxyl ions and to promote transport hydronium ions.

8. As noted at paragraph 4 above, cationic spacer 134 would be understood by a person skilled in the art to be a layer of cation exchanging material, such as cation exchange resin. According to Mir, at column 7, lines 35 *et seq.*, cation exchange materials can be woven fabric, non-woven fabric (randomly oriented strands), extruded netting, open cell foam, or combined exchange particles. Mir also notes, at column 7, lines 53 *et seq.*, that the combined ion exchange particles are sufficiently large so as to cause an acceptably low pressure drop in flow channels formed therethrough and, likewise, the open cell foam and woven and non-woven fabric materials provide an interconnected network of flow passages therethrough. I conclude that the layer of cation exchanging material 134 must have flow passages that allow water to flow therethrough, and because the cation exchanging material has flow passages, it cannot provide a cation-specific separation transport phenomenon. I also conclude that one skilled in the art would understand that a layer of cation exchange material, i.e., cation exchange resin cannot inhibit transport of anionic species, i.e., hydroxyl ions, while promoting transport of cationic species, i.e., hydronium ions. Thus, the use of a cation exchanging material in place of a cation membrane would not provide an essential feature of a bipolar membrane, or a laminate of juxtaposed layers of anion and cation membranes

9. I further rely on Mir's explanation at column 8, lines 45 *et seq.*, that the membranes prevent the transfer of cations to the acidic brine compartment in spacer 134 and of anions to the basic brine compartment in spacer 132, and on the species-separating feature of bipolar membranes to conclude that cation membranes and cation exchanging materials cannot be considered to be equivalent by one skilled in the art. I further note Mir's explanation that the bipolar membrane is functionally equivalent to the anion membrane/cation membrane

lamination. If one were to substitute cation exchange resin for cation membrane 142, then the yield of hydronium species would notably decrease because (1) the cation exchange resin (substituted for membrane 142) would allow bulk liquid to contact the anion membrane surface 152 and thus not completely effect transport of cationic species away from the surface of anion membrane 152, nor (2) would it inhibit or block the transport of anions, such as chlorides, from passing through anion membrane 152 across from the subdivided channel formed by cationic spacer 134, and into the channel formed by anionic spacer 132. Indeed, I also conclude that substituting resin for the membrane would not only limit the acid-generating capability promoted by Mir, but would also reduce, for a given liquid flow, the acid concentration that would occur in the sub-channel formed by cationic spacer 134. Similarly, the reduced level of water splitting would result in a reduced degree of hydroxide ion content in the sub-channel formed by anion spacer 132.

10. I also note similarly that bipolar membranes or membranes having a layer of cation selective membrane against a layer of anion selective membrane serve to prevent or inhibit undesirable ionic species from reaching the interface of the cationic selective layer and the anion selective layer. Inhibiting or reducing the level of cationic species and anionic species at the interface increases the yield of OH_3^+ and OH^- species generated. If anionic and cationic species were present at the interface, the applied electrical current would be conducted through such transporting species instead of facilitating water disproportionation to generate the OH_3^+ and OH^- species that would conduct the electrical current. Mir also notes that a low concentration of ions promotes water splitting. (See Mir at column 2, lines 62-64.) I conclude that one skilled in the art, seeking to split water while also concentrating acid or base species, would have sought to reduce the concentration of any interfering anionic and/or cationic species at the disproportionation interfaces by utilizing bipolar membranes or membranes having a layer of anionic selective character and a layer of cationic selective character because doing so would improve the yield of hydronium and hydroxyl species. I

also conclude that even if some water splitting occurs at contacting anionic and cationic surfaces, substituting the cationic membrane 142 for cationic spacer 134 in the disclosure of Mir would not inhibit the transport of chloride species (introduced in the brine solution into concentrating channel 150) through the anionic spacer 152 (and the anionic spacer 132) and, in turn, would not have provided conditions of low ionic species concentration at the membrane surfaces that are conducive to the disproportionation of water, and also would not have provided conditions that enable elevated acid or base concentration in the concentration channel. I therefore conclude that one skilled in the art would not have considered an anionic selective membrane to be equivalent to anionic exchange media because anion selective membranes, especially in the context of Mir's disclosure, would not have provided the desired water splitting performance sought by Mir.

11. Because cation resins cannot be considered as equivalent to cation selective membranes, one skilled in the art would not have modified the concentrating channel illustrated in FIG. 8 of Mir by substituting cation resin for cation membrane 142.

12. I, the undersigned, declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under § 1001 of title 18 of the United States Code, and that such willful false statements may jeopardize the validity of this document and any patent which may issue from the above-identified patent application.

August 26, 2008
Date

G. C. G.
Gary C. Ganzi